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Effect of Various Doses and Sources of Sulphur in the Growth and Yield Attributing Traits of Indian Mustard (*Brassica juncea*)

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ABSTRACT: *A field experiment was conducted during Rabi season of 2012-2013, at, Agricultural Research Farm, Rajiv Gandhi South Campus, Barkachha, Mirzapur to evaluate the response of different doses (15, 30 and 45 kg S ha^{-1}) and sources (elemental sulphur, gypsum and single super phosphate) of sulphur on nutrient uptake by seed as well as yield, and nutrient content in mustard seed and stover after crop harvest. Nutrient uptake, yield, and nutrient content in mustard were significantly improved by the application of different levels of sulphur. Amongst sulphur sources, the application of gypsum @ 40 kg S ha^{-1} showed significant superiority over others.*

Keywords: *Sulphur, Indian mustard, growth & yield.*

INTRODUCTION

In the crop management of oil seed, sulphur plays an important role and is now being recognized as fourth major nutrient in addition to N, P, K and perform many physiological functions like synthesis of oil, sulphur containing amino acids, chlorophylls, certain vitamins and the glucosinolates (Bones and Rossiter, 1996). It is the third most important source of vegetable oil of the world. Rapeseed mustard is the second most important oilseed crop of India, next to soybean. Share of India in cultivated area and production of rapeseed mustard is 21.7% and 10.7% of the world, respectively (USDA 2010). The production and productivity of mustard in India is almost static during the last decade and ranging between 1 and 1.2 tonnes /ha, which is much below the worlds average of 1.98 tones/ha. When we compare productivity of Germany (4.3 tonnes/ha), France (3.8 tonnes/ha) and UK (3.4 tonnes/ha) with that of India, the yield gaps further widen (FAOSTAT 2009).

However, its productivity is low due to poor soil conditions and inadequate use of fertilizers. The major nutrients sulphur plays an important role in Indian mustard, which are insufficient in most of Indian soil. According to Tandon (1991) widespread sulphur deficiency has been observed in crops and soils in 120 districts of India irrespective of soil texture and cropping pattern, including Varanasi and Mirzapur districts of eastern Uttar Pradesh.

Coarse textured soils which have low sulphur retentive capacity, application of 20-50 kg S ha^{-1} is recommended (Tandon, 1990). Sulphur fertilization in deficient soils is known to increase seed yield of irrigated mustard by 12 to 48 percent (Aulakh and Pasricha, 1988). The substantial increase in mustard yield due to sulphur application (Sharma, 1994;).

MATERIALS AND METHODS

Experimental site, Agricultural Research Farm, Rajiv Gandhi South Campus, Soil and Water Conservation Barkachha, Mirzapur is situated at 25° 10′ latitude, 82° 37′ longitude and at altitude of 146 meters above mean sea level. It falls under agro-climatic zone III A (semi-arid eastern plain zone) of *Vindhyan* region of India. *Vindhyan* soil comes under rainfed and invariably poor fertility status. The climate of the region is semi arid to sub humid with hot dry summer and cold winters. The experimental field top soil (0-15 cm) initially was well levelled sandy loam, having good irrigation facility and neutral in reaction (6.7

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pH), electrical conductivity (0.22dS^{-1}m) and poor in organic carbon (0.23%), available nitrogen (197.0 kg ha^{-1}), available phosphorus (9.68 kg ha^{-1}) as well as available sulphur (23.19 kg ha^{-1}) and moderate in potash (288.53 kg ha^{-1}). The experiment was laid out in Randomized Block Design (RBD) with nine treatments, replicated thrice in addition to control plot. The treatments consisted of three levels of sulphur with three sources *viz.* elemental sulphur, gypsum and single superphosphate (15, 30 and 45 kg S ha^{-1}) and treatments symboled as T_1 (control), T_2 (15.0 kg S ha^{-1} through elemental sulphur), T_3 (30.0 kg S ha^{-1} through elemental sulphur), T_4 (45.0 kg S ha^{-1} through elemental sulphur), T_5 (15.0 kg S ha^{-1} through gypsum), T_6 (30.0 kg S ha^{-1} through gypsum), T_7 (45.0 kg S ha^{-1} through gypsum), T_8 (15.0 kg S ha^{-1} through single superphosphate), T_9 (30.0 kg S ha^{-1} through single superphosphate) and T_{10} (45.0 kg S ha^{-1} through single superphosphate). In addition to the sulphur, recommended dose of N, P and K (80, 40 and 40 kg ha^{-1}) were also applied through Urea, DAP and Muriate of Potash in each plot, respectively.

The field experiment was laid out during Rabi season of 2012-2013 in open field in which crop was sown (variety Parasmani- 8) at 24 October 2012 in rows at a spacing of 30 x 20 cm. and just after sowing, the entire experimental plot was covered by using *Leucaena leucorcephala* leaves @ 5.0 tonnes per hectare to conserve the soil moister. Cultural activities like thinning, irrigation and plant protection measure were carried out properly as per crop recommendation. All the treatments *viz.* doses and sources of sulphur and recommended dose of phosphorus, potash and half of the nitrogen was applied at the time of sowing and remaining half dose of nitrogen was top dressed after first irrigation. The seed and stover was collected at maturity and analysed for N and S by adopting standard procedure.

The observations *viz.* plant height, branches per plant, dry matter accumulation, siliquae per plant, length of siliquae, seeds per siliquae, test weight, seed yield and Stover yield were recorded as per standard methods. Nutrient content in grains and stover was estimated by standard protocols and nutrients uptake by grains and stover was calculated from the nutrient content in the seed grain and yield of seed grains and stover. The data were analyzed statistically by analysis of variance as suggested by Cochran and Cox (1957).

RESULTS AND DISCUSSION

Application of sulphur in Indian mustard through elemental sulphur, Gypsum and single super phosphate was found equally effective for plant height, branches per plant, dry matter accumulation (g/plant), siliquae/plant, length Of siliquae (Cm), seed / siliquae, test weight, seed yield (q ha^{-1}), Stover yield (q ha^{-1}). Maximum growth and yield attributing character was observed with application of 45 kg S through Gypsum (T_7) which remained at par with T_4,T_6, T_9, T_{10}, respectively and significantly superior over the rest of the treatments. However, there was no significant difference between 45 kg and 30 kg S ha^{-1} in respect of branches/plant, length of siliquae, seed yield, stover yield(q ha^{-1}) and harvest index.

Table 1
Effect of Source and Level of Sulphur on Growth, Yield and Yield Attributes of Indian Mustard.

Treatments	*Plant height (cm)*	*Branches per plant (Primary + secondary)*	*Dry matter production (g per plant)*	*Siliquae per plant (No.)*	*Siliquae length (cm)*	*Seeds per Siliquae (No.)*	*Test Weight(g)*	*Seed yield (q ha^{-1})*	*Stover yield (q ha^{-1})*	*Harvest index (%)*
T_1	124.39	11.46	22.56	105.60	4.18	12.47	4.62	9.27	46.11	20.10
T_2	131.02	14.43	29.48	122.67	4.23	13.08	4.80	11.54	50.62	22.79
T_3	162.13	18.13	32.89	145.86	5.17	13.37	5.36	12.54	56.27	22.27
T_4	187.01	19.16	42.67	162.74	5.36	15.07	5.54	12.66	57.72	21.93
T_5	150.42	17.14	42.56	154.18	5.36	13.10	5.14	13.86	57.47	24.12
T_6	182.38	20.05	44.69	170.53	5.44	14.19	5.74	14.04	59.75	23.36
T_7	200.37	20.73	46.45	184.30	5.62	16.16	6.02	14.21	60.84	24.50
T_8	144.25	16.23	38.01	138.46	5.29	14.33	5.50	13.10	54.09	21.50
T_9	190.57	19.18	45.14	169.67	5.38	14.21	5.50	13.30	57.56	22.75
T_{10}	191.63	19.92	46.68	173.72	5.55	15.41	5.90	13.78	60.99	23.85
SEm (±)	8.320	0.865	2.030	7.266	0.166	0.403	0.156	0.537	1.702	0.931
CD (p=0.05)	24.721	2.571	6.031	21.588	0.492	1.198	0.464	1.595	5.057	2.765

Application of Gypsum as a source of sulphur proved significantly superior over the Elemental sulphur and single super phosphate. This result was might be due to the effect of additional supply of calcium. Gypsum contains additional calcium which was not supplied with the other sulphur fertilizers. This might be because calcium enhanced the cell division and cell multiplication and tissue differentiation. Similar results are in agreement with the findings of Khanpara *et al.* (1993). The better growth with higher rate of sulphur application might be due to increased availability of sulphur brought about not only vigorous growth of plant that developed to their full potential in increasing value of growth attributes but also photosynthesis. This phenomenon was quite natural because of greater availability of sulphur in the soil and its stimulating effect on the growth of plant. Shoot height was affected by the stimulation due to sulphur that may be attributed to its essentiality in cell division. He also suggested that sulphur is important in the activity of meristematic tissues and development of shoot. Importance of sulphur in cell division, cell elongation and setting of cell structure was also stated by Hearth and Ormarod (1971).

The nitrogen and sulphur content (%) increased significantly with the increasing level of sulphur. Significantly highest nitrogen and sulphur content in seed and straw (3.88 and 0.79 %) were recorded underT_7 by the application of sulphur @ 45.0 kg ha^{-1} through gypsum and at par with T_4 andT_6 which was significantly superior over the rest treatment.

Nitrogen and sulphur uptake by mustard seed and stover (50.13 and 45.30 kg/ha) and (13.55 and 23.79kg/ha) respectively was recorded under T_7 by the application of sulphur @ 45.0 kg ha^{-1} through gypsum. Among the sources of sulphur, gypsum was responsible highest increase in the sulphur content and uptake by seed and straw of mustard crop Ahmad and Masood (2005) in Uttar Pradesh, India, to evaluate the relative effectiveness of three sulphur fertilizers namely gypsum, single superphosphates and iron pyrite on sulphur, nitrogen, phosphorus and potassium availability to two cultivars of rapeseed-mustard (*Brassica juncea*). Gypsum proved much better in enhancing the leaf sulphur, nitrogen, phosphorus and potassium content as compared to other two fertilizers, while iron pyrite gave the poorest response.

Table 2
Effect of Source and Level of Sulphur on Nitrogen and Sulphur Uptake by Mustard

Treatments	*Nitrogen content (%)*		*Nitrogen uptake (kg ha^{-1})*			*Sulphur content (%)*		*Sulphur uptake (kg ha^{-1})*		
	Seed	*Stover*	*Seed*	*Stover*	*Total*	*Seed*	*Stover*	*Seed*	*Stover*	*Total*
T_1	2.71	0.54	25.15	25.02	50.17	0.54	0.25	5.01	11.54	16.55
T_2	3.08	0.63	35.57	31.84	67.41	0.60	0.28	6.89	14.15	21.04
T_3	3.36	0.70	42.39	39.59	81.98	0.68	0.31	8.52	17.46	25.98
T_4	3.85	0.77	49.02	44.82	93.84	0.88	0.36	11.19	20.78	31.97
T_5	3.53	0.71	49.08	40.71	89.80	0.85	0.35	11.67	19.98	31.65
T_6	3.63	0.72	51.34	43.69	91.03	0.92	0.37	13.24	22.05	35.29
T_7	3.88	0.79	50.13	45.30	95.43	0.94	0.39	13.55	23.79	37.34
T_8	3.18	0.70	41.69	37.76	79.45	0.69	0.31	9.08	16.73	25.81
T_9	3.23	0.71	45.27	43.96	89.23	0.80	0.34	11.25	20.48	31.73
T_{10}	3.35	0.74	44.64	42.65	87.29	0.88	0.36	11.70	20.72	32.42
SEm (±)	0.097	0.021	2.551	2.430	4.590	0.032	0.012	0.711	0.934	1.448
CD (p=0.05)	0.289	0.063	7.579	7.219	13.639	0.094	0.036	2.111	2.776	4.303

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